MODELING THE CROSS-MARGIN EXCHANGES AND INTERACTIONS BETWEEN COASTAL AND DEEP-OCEAN

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LONG-TERM GOALS

The specific goals of this proposal are toward the understanding of the physical mechanisms that control the shelf, shelf/break, and slope dynamics and the cross-margin interactions between the coastal and deep-ocean regions.

OBJECTIVES

- to evaluate whether a moderately parallel processing environment is suitable for ocean modeling applications;
- to investigate the feasibility of a two-way communication scheme between the large-scale basin and the high-resolution coastal models.
- to understand and model the interaction between the deep and shallow waters and the mechanisms through which the shelf and open-ocean exchange mass and momentum;
- to understand and model the climatology and seasonal variability of the Mississippi Bight (MB) and determine the long-lasting structures as opposed to transitory features;
- to understand and quantify the relative importance of the transitory vs. the long-lasting features in the cross-margin transfers between the MB and the Gulf of Mexico (GOM).

APPROACH

The approach is to implement a two-way communication modeling system that connects large-scale, basin-wide and high-resolution, coastal models. The Princeton Ocean Model is the model of choice for the development of a procedure in which modules, corresponding to the basin and coastal domains, are executed in parallel and communicate the coupling

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variables to each other. The approach offers the benefit of modeling coastal environments, taking into account the mutual interactions between the shallow and deep waters, without the computational burden of configuring the basin domain at the high resolution required by coastal applications.

The coupled model system is tested and evaluated by analyzing the water mass exchanges between the MB Shelf and the GOM.

WORK COMPLETED

The two-way nesting procedure and the parallellization of the system has been completed. The configuration of the GOM and MB models is completed, and the climatological data sets have been acquired.

The coupled system is highly portable. C-preprocessor directives control whether the models are executed independently or in parallel, the choice of the communication algorithms, and the message-passing libraries. There are two options for controlling the communications between the coarse and fine grids based on the PVM and MPI message passing libraries. Currently, the simulations are executed on the Origin 2000 and Power Challenger platforms. A version with PVM message passing software is available for the C-90 and Cray YMP, but has not been extensively tested, yet.

Several experiments are being conducted to verify the sensitivity of the nesting scheme to the choice of interpolation algorithm and frequency of the communications.

RESULTS

The nesting procedure is formulated by assuming that there are two dominant scales: the small, energy-containing features and the large, slowly-varying flow. The two-way algorithm develops as follows: 1) The basin model determines the location of the inflow and outflow ports at the open boundaries of the coastal model: inflow conditions are treated by interpolating algorithms, and radiation-like schemes are imposed at the outflow areas. 2) A feed-back procedure from the MB to the GOM model parameterizes and controls the transfer of energy of the sub-scale (relative to the coarse-grid spacing) features.

Fig. 1. illustrates an intrusion of the Loop Current over the MB domain. A warm-water filament is carried over the slope and shelf along the eastern side of DeSoto Canyon. As

the filament hits the western side of the slope, it splits in a mushroom-like feature and entrains cold shelf slope on both sides.

IMPACT/APPLICATIONS

This research addresses relevant issues for the Navy's operational activities on littoral regions. It provides:

- a modeling approach for the coastal areas that takes into account the mutual interactions between shallow and deep waters (i.e., physically accurate),
- a coupled system that is computationally efficient and higly portable (i.e., cost effective and easily reconfigured for other coastal regions)
- an evaluation as to whether moderately parallel environments are suitable for ocean applications (i.e., in line with the new computer technologies)

TRANSITIONS

This project provides a transition of knowledge and nesting techniques to be used in modeling coastal regions

RELATED PROJECTS

This program fits well with the DoD High Performance Computing Modernization Office interests in developing scaleable (i.e., workstation clusters or multiprocessor platforms) ocean and atmospheric modeling applications.

Under the sponsorship of the MMS a multi-year hydrographic survey program is in progress in the DeSoto Canyon area and Northeastern Gulf. At the University of Colorado, R. Leben is developing a nearly real-time database of TOPEX/ERS-2 altimetry data. Both programs provide a valuable set of data and measurements for our model initialization and model-data comparison.

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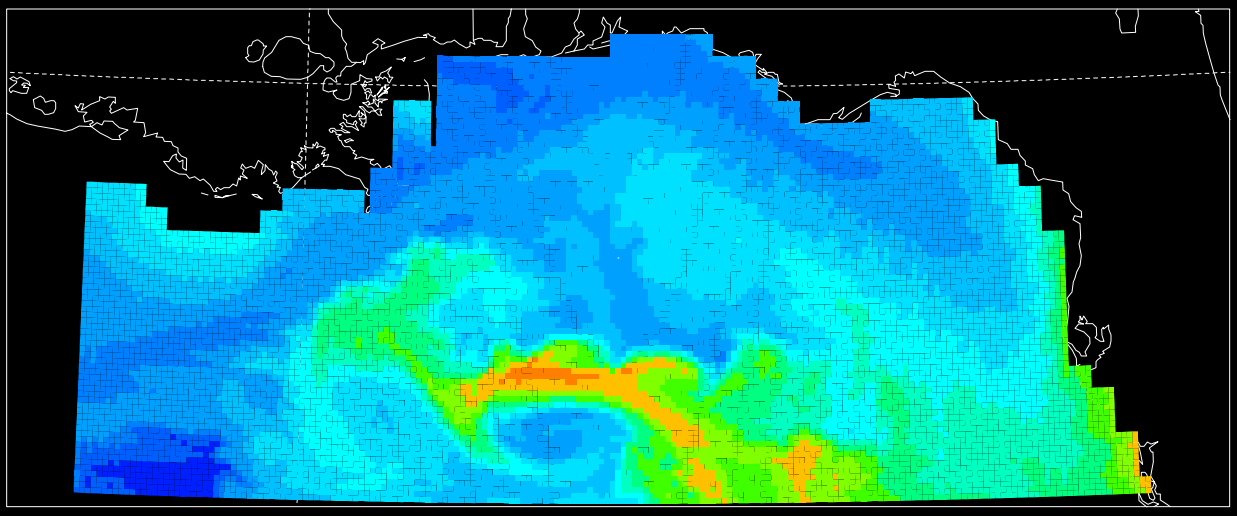
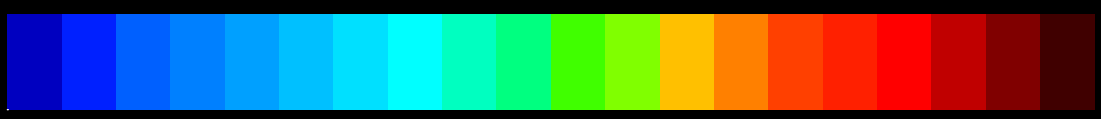
Day = 440





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